CLAIMS:

1. A three-dimensional (3-D) integrated chip system, comprising:

a first wafer including one or more integrated circuit (IC) devices;

a second wafer including one or more integrated circuit (IC) devices; and

a metal bonding layer deposited on opposing surfaces of the first and second wafers at designated locations to establish electrical connections between active IC devices on the first and second wafers and to provide metal bonding between the adjacent first and second wafers, when the first wafer is pressed against the second wafer using a flexible bladder press to account for height differences of the metal bonding layer across the opposing surfaces of the first and second wafers.

2. The three-dimensional (3-D) integrated chip system as claimed in claim 1, wherein the metal bonding layer includes a plurality of Copper (Cu) lines on opposing surface of the first and second wafers to serve as electrical contacts between active IC devices on both the first and second wafers.

3. The three-dimensional (3-D) integrated chip system as claimed in claim 1, wherein the flexible bladder press is a hollow steel container including an input valve arranged to input air pressure, and a bottom membrane positioned over the surface of the first wafer to

apply the pressure differently at different points on the first wafer as the first wafer is pressed against the second wafer to account for the height differences of the metal bonding layer across the opposing surfaces of the first and second wafers.

4. The three-dimensional (3-D) integrated chip system as claimed in claim 1, wherein the pressure required to account for the height differences of the metal bonding layer across the opposing surfaces of the first and second wafers is determined based on the following equations:

$$\delta = \frac{qL^4}{8EI}, \text{ and } \qquad I = \frac{bh^3}{3}$$

where "δ" indicates the total deflection on the first wafer; "L" indicates the length of the first wafer; "q" indicates the load intensity; "E" is the Young modulus of elasticity of the first wafer; and "I" indicates the moment of inertia of the rectangular cross-section; and

where "h" indicates the thickness of the first wafer, and "b" indicates the cross-section dimension of the first wafer.

5. The three-dimensional (3-D) integrated chip system as claimed in claim 1, wherein the first wafer is thinner than the second wafer to conform to the height differences of the metal bonding layer across the opposing surfaces of the first and second wafers.

6. The three-dimensional (3-D) integrated chip system as claimed in claim 1, wherein the flexible bladder press is an autoclave including an input valve arranged to input high-pressure gas into a chamber; a heater arranged to heat the gas at a predetermined temperature; and at least one vacuum bag arranged to contain the first and second wafers in position for metal bonding.

7. The three-dimensional (3-D) integrated chip system as claimed in claim 6, wherein the vacuum bag is a flexible bag that is evacuated and then sealed to ensure that the first and second wafers are bonded, via the metal bonding layer.

8. A wafer bonding method, comprising:

selectively forming metallic bumps on opposing surfaces of adjacent wafers each including one or more integrated circuit (IC) devices;

selectively aligning the adjacent wafers to form a stack; and

bonding the metallic bumps on the surface of one wafer with the metallic bumps on the surface of the other wafer to establish electrical connections between active IC devices on the adjacent wafers using a flexible bladder press to account for height differences of the metallic bumps across the opposing surfaces of the adjacent wafers.

9. The wafer bonding method as claimed in claim 8, wherein the metallic bumps are Copper (Cu) bumps deposited on opposing surface of the first and second wafers to serve as

electrical contacts between active IC devices on both the first and second wafers.

10. The wafer bonding method as claimed in claim 8, wherein the flexible bladder press is a hollow steel container including an input valve arranged to input air pressure, and a bottom membrane positioned over the surface of the first wafer to apply the pressure differently at different points on the first wafer as the first wafer is pressed against the second wafer to account for the height differences of the metallic bumps across the opposing surfaces of the first and second wafers.

11. The wafer bonding method as claimed in claim 8, wherein the pressure required to account for the height differences of the metallic bumps across the opposing surfaces of the first and second wafers is determined based on the following equations:

$$\delta = \frac{qL^4}{8EI}, \text{ and } \qquad I = \frac{bh^3}{3}$$

where "δ" indicates the total deflection on the first wafer; "L" indicates the length of the first wafer; "q" indicates the load intensity; "E" is the Young modulus of elasticity of the first wafer; and "I" indicates the moment of inertia of the rectangular cross-section; and

where "h" indicates the thickness of the first wafer, and "b" indicates the cross-section dimension of the first wafer.

12. The wafer bonding method as claimed in claim 8, wherein the first wafer is thinner than the second wafer to conform to the height differences of the metallic bumps across the opposing surfaces of the first and second wafers.

13. The wafer bonding method as claimed in claim 8, wherein the flexible bladder press is an autoclave including an input valve arranged to input high-pressure gas into a chamber; a heater arranged to heat the gas at a predetermined temperature; and at least one vacuum bag arranged to contain the first and second wafers in position for metal bonding.

14. The wafer bonding method as claimed in claim 13, wherein the vacuum bag is a flexible bag that is evacuated and then sealed to ensure that the first and second wafers are bonded, via the metallic bumps.

15. A three-dimensional (3-D) integrated chip system, comprising:

a first wafer including one or more integrated circuit (IC) devices, and metallic bumps arranged to electrical interconnection;

a second wafer including one or more integrated circuit (IC) devices, and metallic bumps arranged for electrical interconnection and with alignment with the first wafer to form a stack; and

a flexible bladder press arranged to press the first wafer against the second wafer to bond the metallic bumps on the surface of the first wafer with the metallic bumps on the surface of the

second wafer and establish electrical connections between active IC devices on the adjacent wafers.

16. The three-dimensional (3-D) integrated chip system as claimed in claim 15, wherein the flexible bladder press is arranged to press the first wafer against the second wafer to account for height differences of the metallic bumps across the opposing surfaces of the first and second wafers.

17. The three-dimensional (3-D) integrated chip system as claimed in claim 15, wherein the flexible bladder press is a hollow steel container including an input valve arranged to input air pressure, and a bottom membrane positioned over the surface of the first wafer to apply the pressure differently at different points on the first wafer as the first wafer is pressed against the second wafer to account for the height differences of the metallic bumps across the opposing surfaces of the first and second wafers.

18. The three-dimensional (3-D) integrated chip system as claimed in claim 15, wherein the pressure required to account for the height differences of the metallic bumps across the opposing surfaces of the first and second wafers is determined based on the following equations:

$$\delta = \frac{qL^4}{8EI}, \text{ and } \qquad I = \frac{bh^3}{3}$$

where "δ" indicates the total deflection on the first wafer; "L" indicates the length of the first wafer; "q" indicates the load intensity; "E" is the Young modulus of elasticity of the first wafer; and "I" indicates the moment of inertia of the rectangular cross-section; and

where "h" indicates the thickness of the first wafer, and "b" indicates the cross-section dimension of the first wafer.

19. The three-dimensional (3-D) integrated chip system as claimed in claim 15, wherein the first wafer is thinner than the second wafer to conform to the height differences of the metallic bumps across the opposing surfaces of the first and second wafers.

20. The three-dimensional (3-D) integrated chip system as claimed in claim 15, wherein the flexible bladder press is an autoclave including an input valve arranged to input high-pressure gas into a chamber; a heater arranged to heat the gas at a predetermined temperature; and at least one vacuum bag arranged to contain the first and second wafers in position for metal bonding.